RELATIVE RISK SITE EVALUATION

[BUCKLEY AFB, CO]

Introduction

The Department of Defense (DoD) identified certain per- and polyfluoroalkyl substances (PFAS) as emerging contaminants of concern which affected installations across the Air Force. Specifically, perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS) are components of legacy Aqueous Film Forming Foam (AFFF) that the Air Force began using in the 1970s as a firefighting agent to extinguish petroleum fires. The U.S. Environmental Protection Agency (EPA) issued a lifetime drinking water Health Advisories (HA) for PFOS and PFOA, and health-based regional screening levels for PFBS.

The Air Force has systematically evaluated potential AFFF releases on all Installations and former Installations. It began with the Preliminary Assessments, or PAs, that identified potential release areas. First responders, fire chiefs, and hangar staff were interviewed to determine where a release or a spill may have occurred on an Installation (for example, aircraft crash site or an accidental hangar AFFF release). Once the information in the PA was collected, we began Site Inspections, or SIs, to take soil and water samples and analyzed the media for 16 different PFAS compounds at the potential release areas. The intention of the SI was to determine if a release had occurred to determine the impacts to soil and/or groundwater. The next step in the process is call the Relative Risk Site Evaluation, or RRSE, which is a tool used to prioritize funding for which sites/Installations have the highest priority to begin a Remedial Investigation, or RI. Air Force Installations are at the beginning of the more detailed investigative stage, the RI, to determine, where action is needed and to identify remedial technologies.

Buckley AFB PA and SI can be found at AFCEC CERCLA Administrative Record (AR): ar.afcec-cloud.af.mil. Scroll to the bottom of the page and click on "Continue to site", then select "Active", scroll down the **Installation List** and click on Buckley AFB, then enter 539546 in the "AR #" field for the PA. For the SI, enter 586675 and 586676. Then click "Search" at the bottom of the page. Click on the spy glass to view the document.

More information on the Air Force response to PFOS and PFOA can be found at: https://www.afcec.af.mil/WhatWeDo/Environment/Perfluorinated-Compounds/

Acronyms

AFFF - Aqueous Film Forming Foam

AST – Aboveground Storage Tank

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act

CHF – Contaminant Hazard Factor

EPA – US Environmental Protection Agency

FTA – Fire Training Area

HA – Health Advisory

MPF – Migration Pathway Factor

PA – Preliminary Assessment

PFAS - Per-and polyfluoroalkyl substances

PFBS – Perfluorobutane sulfonate

PFOS - Perfluorooctane sulfonate

PFOA - Perfluorooctanoic acid

RCRA – Resource Conservation and Recovery Act

RF – Reception Factor

RI – Remedial Investigation

RRSE – Relative Risk Site Evaluation

SI – Site Inspection

SWMU – Solid Waste Management Unit

RELATIVE RISK SITE EVALUATION

[BUCKLEY AFB, CO]

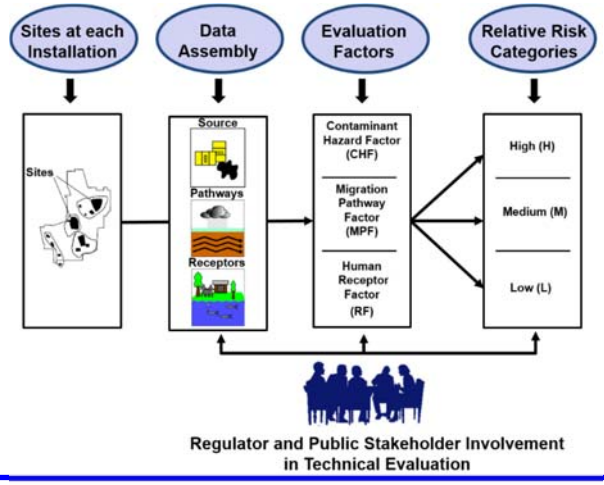
Q. What is the Relative Risk Site Evaluation (RRSE)?

A. RRSE is a methodology to sequence environmental restoration work used by the Department of Defense (DoD). The RRSE process is used to evaluate the relative risk posed by an environmental restoration site in relation to other sites. The DoD fundamental premise in site prioritization is "worst first," meaning the DoD Component shall address sites that pose a relatively greater potential risk to public safety, human health, or the environment before sites posing a lesser risk. Relative risk is not the sole factor in determining the sequence of environmental restoration work, but it is an important consideration in the priority setting process. The methodology is described in the DoD, Relative Risk Site Evaluation Primer, Summer 1997 Revised Edition https://www.denix.osd.mil/references/dod/policy-guidance/relative-risk-site-evaluation-primer/RRSE_Primer_Summer1997.pdf

Q. What is the RRSE framework?

A. The RRSE framework provides a DoD-wide approach for evaluating the relative risk to human health and the environment posed by contamination present at sites. The Relative Risk Site Evaluation Concept Summary (shown in the figure) illustrates the selection of sites, evaluation of the site data using three evaluation factors, and placement into high, medium, and low categories. The relative risk site evaluation framework is based on information fundamental to risk assessment: sources, pathways, and receptors to sequence restoration work. The RRSE is not a baseline risk assessment or health assessment in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. Regulators and public stakeholders in the environmental restoration process are provided the opportunity to participate in the process in accordance with the DoD Defense Environmental Restoration Program.

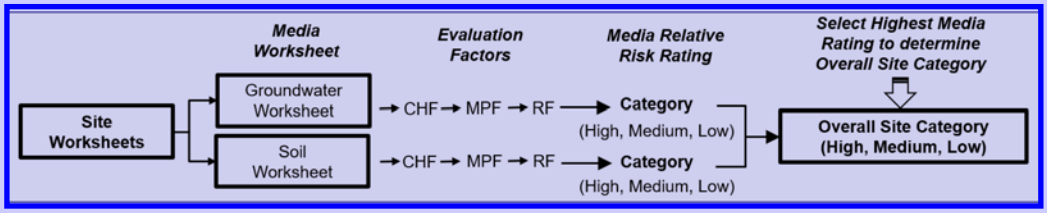
Relative Risk Site Evaluation Concept Summary



Sites at Each Installation

Q. What restoration sites are required to be evaluated in the RRSE process?

A. Restoration sites in CERCLA phases prior to remedy-in-place are evaluated in the process. Worksheets are developed environmental media (such as, groundwater and surface soil) at each site. Environmental media lacking sufficient information to conduct a relative risk evaluation are assigned a "Not Evaluated" designation. The figure shows the process for a media to be evaluated using the contaminant hazard factor (CHF), the migration pathway factor (MPF), and the receptor factor (RF). Each media is scored to obtain a relative risk rating of High, Medium, or Low. The highest media rating determines the Overall Site Category.



Q. How is the Contaminant Hazard Factor (CHF) determined?

A. The Contaminant Hazard Factor (CHF) is determined by dividing the maximum level for a contaminant at each site by the approved screening values (i.e., comparison values). Contaminant concentration ratios are totaled to arrive at a Contaminant Hazard Factor (CHF). A CHF sum of greater than 100 earns a High ranking. Moderate is when the total is 2 to 100. Minimal is when a CHF is less than two.

FOR MORE INFORMATION

Air Force Civil Engineer Center
Environmental Restoration Program
www.afcec.af.mil

AFCEC CERCLA
Administrative Record (AR)
ar.afcec-cloud.af.mil/

Q. How is the Migration Pathway Factor (MPF) determined?

A. The movement of contamination at a site is evaluated and assigned a Migration Pathway Factor (MPF) rating.

Ratings for MPFs are designated as: evident, potential, or confined (for High, Medium, and Low). Evident exposure means the contamination is at a point where exposure to humans or the environment can occur, such as at a drinking water well. Potential ratings are given to sites where exposure may happen. A confined rating is given to sites where a low possibility for exposure may occur.

Q. How is the Receptor Factor (RF) determined?

A. The Receptor Factor (RF) is determined by a receptor's, such as humans, potential to come into contact with contaminated media. RFs are designated as: identified, potential, or limited (High, Medium, and Low). Identified rating is given when receptors are in contact or threat of contact with contaminated media. Potential is given when receptor may contact contaminated media. Limited is given when there is little or no contact with contaminated media.

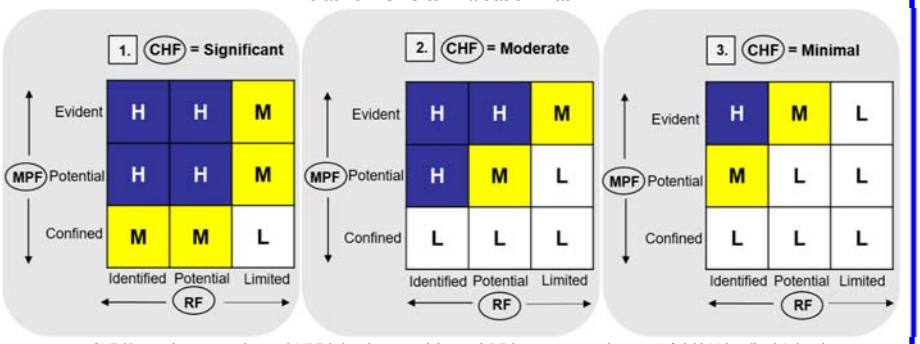
POINT OF CONTACT
Scott Wilson
720-847-7159
scott.wilson.7@us.af.mil

RELATIVE RISK SITE EVALUTION PROCESS, cont.

Media Relative Risk Rating

Q. How is the media relative risk rating determined?
A. Use the chart to determine the relative risk rating for each media evaluated. Start by choosing the CHF result of the evaluation. If the CHF is Significant, use box 1.; if Moderate, use box 2.; if Minimal, use box 3. Then find the MPF and RF results and move to the square where the results meet. That square indicates the media relative risk rating. For example, if the CHF is Significant (go to box 1.), the MPF is Potential and the RF is Identified, then the rating is High (H).

Relative Risk Site Evaluation Matrix



CHF (Contaminant Hazard Factor) MPF (Migration Potential Factor) RF (Receptor Factor) H (High) M (Medium) L (Low)

Overall Site Category

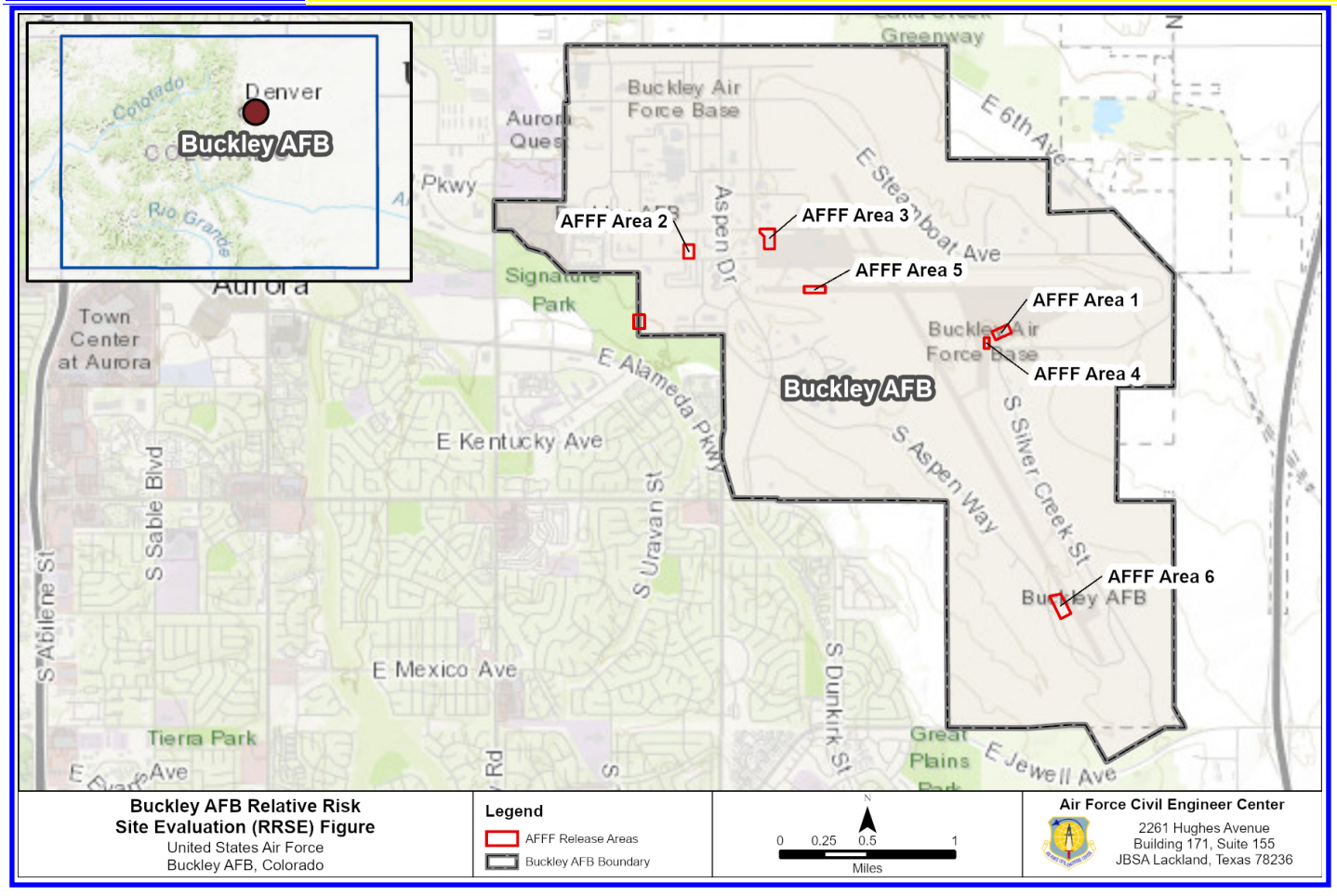
Q. How do I determine the Overall Site Category?
A. The highest relative risk media rating becomes the Overall Site Category for the site. For example, if a site has a groundwater relative risk rating of High, and soil relative risk rating of Low, then the Overall Site Category rating for the site is High.

Regulatory and Stakeholder Involvement

Q. How do I participate as Stakeholder?
A. To offer opportunity to participate in RRSE, the Air Force announces a public comment period in your local newspaper. There is also opportunity to participate during installation Restoration Advisory Boards where active. Installation Restoration Advisory Board meetings are also announced in your local newspaper.

Relative Risk Site Evaluation Summary [BUCKLEY AFB, CO]

Overall Site Category	Site Name (Sites are shown on the map below and RRSE Worksheets are attached)
HIGH	AFFF Area 1, AFFF Area 2, AFFF Area 3, AFFF Area 4
MEDIUM	AFFF Area 5
LOW	AFFF Area 6



Site Background Information			
Installation:	Buckley Air Force Base	**Date:**	6/19/2020
Location (State):	Colorado	**Media Evaluated:**	Groundwater, Soil
Site Name and ID:	Fire Training Area No. 2 - FT001	**Phase of Execution (e.g., RI, Record of Decision (ROD)):**	Remedial Investigation (RI)
RPM's Name:	Scott Wilson	**Agreement Status (e.g., Federal Facility Agreement date signed):**	USEPA Administrative Order RCRA 3008(H)
OVERALL SITE CATEGORY: HIGH			

Site Summary	
Brief Site Description:	AFFF 1 is comprised of an unlined burn area known as Fire Training Area No. 2 and was comprised of an unlined burn area. Fire training exercises were conducted approximately six times a month from the early 1950s to 1972. No record of use of AFFF as an extinguishing material is available. Only a vague outline of the unlined burn area remains visible because it was filled and graded during the construction of adjacent concrete and asphalt aircraft parking ramps.
Brief Description of Pathways:	One unconsolidated, surficial aquifer and three bedrock aquifers (the Denver Formation, the Arapahoe, and the Laramie – Fox Hills Aquifer) are present near BAFB. The surficial and Denver Formation are the most likely aquifers to be impacted by AFFF since the Arapahoe and Laramie – Fox Aquifers are beneath a confining layer. Near BAFB the surficial aquifer is comprised of wind – blown sand and silt and is present from 30 to 60 feet below ground surface. The Denver formation is approximately 850 feet thick beneath BAFB and is primarily composed of shale and claystone (70%) with irregularly dispersed beds of coarser – grained sediment. Regional groundwater flow in the Denver Formation is generally radially outward from the center of the basin and to the northwest to the South Platte River near BAFB. Groundwater flow at AFFF 1 during the SI was to the east.
Brief Description of Receptors:	BAFB receives its drinking water from the City of Aurora. The City of Aurora obtains its drinking water from a series of surface water within the Rocky Mountains that are located up to 180 miles from BAFB. While a small percentage is generated from deep aquifer wells, screened below the Denver Formation, the location of these wells is more than 4 miles from BAFB. Multiple private domestic – use wells, that are less than 150 feet in depth are located within 4 miles of BAFB. The closest, downgradient drinking water well (total depth 60 feet) is approximately 1.1 miles northeast/east of AFFF 1. AFFF 1 is an open area with vegetation covering most of the area with small extents of exposed surface soil or vegetation. Buildings 1603 and 1606 are located immediately west of AFFF 1.Surface soils are potentially accessible by military and civilian personnel.

Groundwater Worksheet

Installation: Buckley Air Force Base

Site ID: FT001 **AFFF Release Area #:** AFFF 1

Contaminant	Maximum Concentration (ug/L)	Comparison Value (ug/L)	Ratios
PFBS	19	40	0.5
PFOA	190	0.04	4750.0
PFOS	99	0.04	2475.0

CHF Scale	CHF Value	Contamination Hazard Factor (CHF)	7225.5
CHF > 100	H (High)	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	M (Medium)		
2 > CHF	L (Low)		
CHF Value		CHF VALUE	H

Migratory Pathway Factor		
Evident	Analytical data or direct observation indicates that contamination in the groundwater has moved to a point of exposure (e.g., well)	
Potential	Contamination in the groundwater has moved beyond the source or insufficient information available to make a determination of Evident or Confined	M
Confined	Analytical data or direct observation indicates that the potential for contaminant migration from the source via groundwater is limited (possibly due to geological structures or physical controls)	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M

Receptor Factor		
Identified	Impacted drinking water well with detected contaminants or existing downgradient water supply well within 4 miles and groundwater is current source of drinking water (EPA Class I or IIA groundwater)	H
Potential	Existing downgradient drinking water well beyond 4 miles with no contaminant detection(s) or no known drinking water wells downgradient and groundwater is currently or potentially usable for drinking water (i.e., EPA Class I or II groundwater) or other beneficial use (e.g., agricultural)	
Limited	No known water supply wells downgradient and groundwater is not considered potential drinking water source and is of limited beneficial use (Class III)	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H
	Groundwater Category	**HIGH**

Soil Worksheet

Installation: Buckley Air Force Base

Site ID: FT001 **AFFF Release Area #:** AFFF 1

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
PFBS	0.036	126	0.0
PFOA	7.2	0.126	57.1
PFOS	8.5	0.126	67.5

CHF Scale	CHF Value	Contamination Hazard Factor (CHF)	124.6
CHF > 100	H (High)	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	M (Medium)		
2 > CHF	L (Low)		
CHF Value		CHF VALUE	H

Migratory Pathway Factor

Evident	Analytical data or observable evidence that contamination is present at a point of exposure	H
Potential	Contamination has moved beyond the source, could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined	
Confined	Low possibility for contamination to be present at or migrate to a point of exposure	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H

Receptor Factor

Identified	Receptors identified that have access to contaminated soil	
Potential	Potential for receptors to have access to contaminated soil	M
Limited	No potential for receptors to have access to contaminated soil	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M
	Soil Category	**HIGH**

Site Background Information			
Installation:	Buckley Air Force Base	**Date:**	6/19/2020
Location (State):	Colorado	**Media Evaluated:**	Groundwater, Soil
Site Name and ID:	Fire Training Area No. 3 - FT005	**Phase of Execution (e.g., RI, Record of Decision (ROD)):**	Remedial Investigation (RI)
RPM's Name:	Scott Wilson	**Agreement Status (e.g., Federal Facility Agreement date signed):**	USEPA Administrative Order RCRA 3008(H)
OVERALL SITE CATEGORY: HIGH			

Site Summary	
Brief Site Description:	AFFF 2 is a former fire training area, which was approximately 100 feet in diameter with an adjacent concrete pad. AFFF 2 is located on the western side of BAFB, west of Building 606 on the north side of A Basin Avenue. The Colorado Air National Guard used AFFF 2 for fire training from 1972 to 1989; approximately 24 fire training exercises occurred annually. Fire training procedures included saturating the surface with water to reduce infiltration, igniting approximately 150 gallons of water contaminated JP-4 jet fuel spread on the pad, and extinguishing the fire with water and 6% AFFF. Approximately 400 gallons of AFFF were used annually. Approximately 40 cubic yards of soil at AFFF 2 were excavated in October 2006, to remove volatile organic compound (VOC) - contaminated soils. Excavation began with soil from 0 to 2 feet bgs near the center of the former fire training area and proceeded laterally and vertically. The excavation floor over the contaminated area was estimated to be approximately 150 square feet. In 2008, the excavated area was paved to serve as a parking lot adjacent to the newly constructed Consolidated Services Administration Building.
Brief Description of Pathways:	One unconsolidated, surficial aquifer and three bedrock aquifers (the Denver Formation, the Arapahoe, and the Laramie - Fox Hills Aquifer) are present near BAFB. The surficial and Denver Formation are the most likely aquifers to be impacted by AFFF since the Arapahoe and Laramie - Fox Aquifers are beneath a confining layer. Near BAFB the surficial aquifer is comprised of wind - blown sand and silt and is present from 30 to 60 feet below ground surface. The Denver formation is approximately 850 feet thick beneath BAFB and is primarily composed of shale and claystone (70%) with irregularly dispersed beds of coarser - grained sediment. Regional groundwater flow in the Denver Formation is generally radially outward from the center of the basin and to the northwest to the South Platte River near BAFB. Groundwater flow at AFFF 2 during the SI was to the northwest.
Brief Description of Receptors:	BAFB receives its drinking water from the City of Aurora. The City of Aurora obtains its drinking water from a series of surface water within the Rocky Mountains that are located up to 180 miles from BAFB. While a small percentage is generated from deep aquifer wells, screened below the Denver Formation, the location of these wells is more than 4 miles from BAFB. Multiple private domestic - use wells, that are less than 150 feet in depth are located within 4 miles of BAFB. The closest, downgradient drinking water well (total depth 120 feet) is approximately 1.3 miles west/northwest of AFFF 2. AFFF 2 is primarily covered by an asphalt parking lot. The remaining areas appear to be vegetated with small extents of surface soil exposed. Building 347 (Consolidated Services Administration) is located west of AFFF 2. Building 606's parking lot is east of AFFF 2. Surface soils are potentially accessible by military and civilian personnel.

Groundwater Worksheet

Installation: Buckley Air Force Base

Site ID: FT005 **AFFF Release Area #:** AFFF 2

Contaminant	Maximum Concentration (ug/L)	Comparison Value (ug/L)	Ratios
PFBS	0.27	40	0.0
PFOA	0.99	0.04	24.8
PFOS	3.6	0.04	90.0
CHF Scale	**CHF Value**	**Contamination Hazard Factor (CHF)**	**114.8**
CHF > 100	**H (High)**	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	**M (Medium)**		
2 > CHF	**L (Low)**		
CHF Value		**CHF VALUE**	**H**

Migratory Pathway Factor		
Evident	Analytical data or direct observation indicates that contamination in the groundwater has moved to a point of exposure (e.g., well)	
Potential	Contamination in the groundwater has moved beyond the source or insufficient information available to make a determination of Evident or Confined	M
Confined	Analytical data or direct observation indicates that the potential for contaminant migration from the source via groundwater is limited (possibly due to geological structures or physical controls)	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M
Receptor Factor		
Identified	Impacted drinking water well with detected contaminants or existing downgradient water supply well within 4 miles and groundwater is current source of drinking water (EPA Class I or IIA groundwater)	H
Potential	Existing downgradient drinking water well beyond 4 miles with no contaminant detection(s) or no known drinking water wells downgradient and groundwater is currently or potentially usable for drinking water (i.e., EPA Class I or II groundwater) or other beneficial use (e.g., agricultural)	
Limited	No known water supply wells downgradient and groundwater is not considered potential drinking water source and is of limited beneficial use (Class III)	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H
	Groundwater Category	**HIGH**

Soil Worksheet

Installation: Buckley Air Force Base

Site ID: FT005 **AFFF Release Area #:** AFFF 2

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
PFOA	0.0095	0.126	0.1
PFOS	0.93	0.126	7.4
CHF Scale	**CHF Value**	**Contamination Hazard Factor (CHF)**	**7.5**
CHF > 100	**H (High)**	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	**M (Medium)**		
2 > CHF	**L (Low)**		
CHF Value		**CHF VALUE**	**M**

Migratory Pathway Factor		
Evident	Analytical data or observable evidence that contamination is present at a point of exposure	H
Potential	Contamination has moved beyond the source, could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined	
Confined	Low possibility for contamination to be present at or migrate to a point of exposure	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H

Receptor Factor		
Identified	Receptors identified that have access to contaminated soil	
Potential	Potential for receptors to have access to contaminated soil	M
Limited	No potential for receptors to have access to contaminated soil	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M
	Soil Category	**HIGH**

Site Background Information			
Installation:	Buckley Air Force Base	**Date:**	6/19/2020
Location (State):	Colorado	**Media Evaluated:**	Groundwater, Soil
Site Name and ID:	Hangar 801 and Outfall #2 - SD006	**Phase of Execution (e.g., RI, Record of Decision (ROD)):**	Remedial Investigation (RI)
RPM's Name:	Scott Wilson	**Agreement Status (e.g., Federal Facility Agreement date signed):**	USEPA Administrative Order RCRA 3008(H)
OVERALL SITE CATEGORY: HIGH			

Site Summary	
Brief Site Description:	AFFF 3 includes Hangar 801 and Outfall #2. Hangar 801 is the main hangar at BAFB and is on the west end of the flight line. Outfall 2 is located southwest of Hangar 801 and represents the surface water runoff discharge point for Hangar 801. Due to drought conditions, surface water and sediment could not be collected for Outfall 2. An AFFF fire suppression system was present in Hangar 801 until 2008. According to fire and wastewater personnel, only one discharge of the AFFF fire suppression system occurred, releasing approximately 400 gallons of Ansulite 3% AFFF mixed with 13,000 to 14,000 gallons of water from the fire suppression system. According to personnel, the discharge should have been diverted through the floor drain into an underground storage tank (UST) . However, the diversion valve failed, which resulted in the solution flowing onto Breckenridge Avenue because of foam expansion (approximately 1,000 to 2,000 gallons). AFFF solution that flowed onto Breckenridge Avenue either entered the stormwater system or remained on the surface and was allowed to evaporate.
Brief Description of Pathways:	One unconsolidated, surficial aquifer and three bedrock aquifers (the Denver Formation, the Arapahoe, and the Laramie – Fox Hills Aquifer) are present near BAFB. The surficial and Denver Formation are the most likely aquifers to be impacted by AFFF since the Arapahoe and Laramie – Fox Aquifers are beneath a confining layer. Near BAFB the surficial aquifer is comprised of wind – blown sand and silt and is present from 30 to 60 feet below ground surface. The Denver formation is approximately 850 feet thick beneath BAFB and is primarily composed of shale and claystone (70%) with irregularly dispersed beds of coarser – grained sediment. Regional groundwater flow in the Denver Formation is generally radially outward from the center of the basin and to the northwest to the South Platte River near BAFB. Groundwater flow at AFFF – 3 during the SI was to the west/northwest.
Brief Description of Receptors:	BAFB receives its drinking water from the City of Aurora. The City of Aurora obtains its drinking water from a series of surface water within the Rocky Mountains that are located up to 180 miles from BAFB. While a small percentage is generated from deep aquifer wells, screened below the Denver Formation, the location of these wells is more than 4 miles from BAFB. Multiple private domestic – use wells, that are less than 150 feet in depth are located within 4 miles of BAFB. The closest, downgradient drinking water well (total depth 120 feet) is approximately 1.6 miles west/northwest of AFFF 3. However, a domestic well of unknown depth is located downgradient of AFFF 3 within the BAFB boundaries. AFFF 3 is primarily covered by Hangar 801 or pavement. The Outfall 2 location is outside BAFB's boundaries to the west of Hangar 801 and is primarily grassy with small extents of surface soil exposed. Surface soil. Surface soils are potentially accessible by military and civilian personnel at Outfall 2. However, access to surface soils at Hangar 801 is limited.

Groundwater Worksheet

Installation: Buckley Air Force Base

Site ID: SD006 **AFFF Release Area #:** AFFF 3

Contaminant	Maximum Concentration (ug/L)	Comparison Value (ug/L)	Ratios
PFBS	0.23	40	0.0
PFOA	0.43	0.04	10.8
PFOS	5.9	0.04	147.5
CHF Scale	**CHF Value**	**Contamination Hazard Factor (CHF)**	**158.3**
CHF > 100	**H (High)**	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	**M (Medium)**		
2 > CHF	**L (Low)**		
CHF Value		**CHF VALUE**	**H**

Migratory Pathway Factor		
Evident	Analytical data or direct observation indicates that contamination in the groundwater has moved to a point of exposure (e.g., well)	
Potential	Contamination in the groundwater has moved beyond the source or insufficient information available to make a determination of Evident or Confined	M
Confined	Analytical data or direct observation indicates that the potential for contaminant migration from the source via groundwater is limited (possibly due to geological structures or physical controls)	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M
Receptor Factor		
Identified	Impacted drinking water well with detected contaminants or existing downgradient water supply well within 4 miles and groundwater is current source of drinking water (EPA Class I or IIA groundwater)	H
Potential	Existing downgradient drinking water well beyond 4 miles with no contaminant detection(s) or no known drinking water wells downgradient and groundwater is currently or potentially usable for drinking water (i.e., EPA Class I or II groundwater) or other beneficial use (e.g., agricultural)	
Limited	No known water supply wells downgradient and groundwater is not considered potential drinking water source and is of limited beneficial use (Class III)	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H
	Groundwater Category	**HIGH**

Soil Worksheet

Installation: Buckley Air Force Base

Site ID: SD006 **AFFF Release Area #:** AFFF 3

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
PFOA	0.00084	0.126	0.0
PFOS	0.03	0.126	0.2
CHF Scale	**CHF Value**	**Contamination Hazard Factor (CHF)**	**0.2**
CHF > 100	**H (High)**		
100 > CHF > 2	**M (Medium)**		
2 > CHF	**L (Low)**		
CHF Value		**CHF VALUE**	**L**

$$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$$

Migratory Pathway Factor		
Evident	Analytical data or observable evidence that contamination is present at a point of exposure	
Potential	Contamination has moved beyond the source, could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined	M
Confined	Low possibility for contamination to be present at or migrate to a point of exposure	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M
Receptor Factor		
Identified	Receptors identified that have access to contaminated soil	H
Potential	Potential for receptors to have access to contaminated soil	
Limited	No potential for receptors to have access to contaminated soil	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H
	Soil Category	**MEDIUM**

Site Background Information			
Installation:	Buckley Air Force Base	**Date:**	6/19/2020
Location (State):	Colorado	**Media Evaluated:**	Groundwater, Soil
Site Name and ID:	Former Fire Station #2 - NA	**Phase of Execution (e.g., RI, Record of Decision (ROD)):**	Remedial Investigation (RI)
RPM's Name:	Scott Wilson	**Agreement Status (e.g., Federal Facility Agreement date signed):**	USEPA Administrative Order RCRA 3008(H)
OVERALL SITE CATEGORY: HIGH			

Site Summary	
Brief Site Description:	AFFF 4 is Building 1606, Former Fire Station #2. AFFF‐4 is located on the east side of the flight line and was built between 1993 and 1999. AFFF‐4 was used as an auxiliary fire station until 2013 and was primarily used for storage and to support fire department activities on the east side of the flight line. AFFF was regularly stored here although an estimate of the quantity or type of AFFF was not available. The building is still standing, although the structure has been deemed unsafe and is not accessible. Annual spray testing was conducted on the pad adjacent to and south of the building within AFFF 4. The date these operations began is unknown. During spray testing, AFFF (3%, manufactured by National Foam) was sprayed onto the concrete pad to limit potential infiltration and allowed to evaporate. All of the fire trucks at the installation were tested, and approximately 10 gallons or less of AFFF were used annually for spray testing.
Brief Description of Pathways:	One unconsolidated, surficial aquifer and three bedrock aquifers (the Denver Formation, the Arapahoe, and the Laramie‐Fox Hills Aquifer) are present near BAFB. The surficial and Denver Formation are the most likely aquifers to be impacted by AFFF since the Arapahoe and Laramie‐Fox Aquifers are beneath a confining layer. Near BAFB the surficial aquifer is comprised of wind‐blown sand and silt and is present from 30 to 60 feet below ground surface. The Denver formation is approximately 850 feet thick beneath BAFB and is primarily composed of shale and claystone (70%) with irregularly dispersed beds of coarser‐grained sediment. Regional groundwater flow in the Denver Formation is generally radially outward from the center of the basin and to the northwest to the South Platte River near BAFB. Groundwater flow at AFFF 4 during the SI was to the east.
Brief Description of Receptors:	BAFB receives its drinking water from the City of Aurora. The City of Aurora obtains its drinking water from a series of surface water within the Rocky Mountains that are located up to 180 miles from BAFB. While a small percentage is generated from deep aquifer wells, screened below the Denver Formation, the location of these wells is more than 4 miles from BAFB. Multiple private domestic‐use wells, that are less than 150 feet in depth are located within 4 miles of BAFB. The closest, downgradient drinking water well (total depth 60 feet) is approximately 1.2 miles northeast of AFFF 4. Several additional domestic water wells of unknown depth are present downgradient of AFFF 4 within 4 miles. AFFF 4 primarily covered by Building 1606 and concrete pavement. The surface soil samples, however were collected along the west side of the East Apron, which is located south of AFFF 4 and Taxiway W. Access to the surface soil is expected to be limited based on their proximity to active operations.

Groundwater Worksheet

Installation: Buckley Air Force Base

Site ID: NA **AFFF Release Area #:** AFFF 4

Contaminant	Maximum Concentration (ug/L)	Comparison Value (ug/L)	Ratios
PFBS	4.5	40	0.1
PFOA	6.8	0.04	170.0
PFOS	30	0.04	750.0

CHF Scale	CHF Value	Contamination Hazard Factor (CHF)	920.1
CHF > 100	H (High)	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	M (Medium)		
2 > CHF	L (Low)		
CHF Value		CHF VALUE	H

Migratory Pathway Factor

Evident	Analytical data or direct observation indicates that contamination in the groundwater has moved to a point of exposure (e.g., well)	
Potential	Contamination in the groundwater has moved beyond the source or insufficient information available to make a determination of Evident or Confined	M
Confined	Analytical data or direct observation indicates that the potential for contaminant migration from the source via groundwater is limited (possibly due to geological structures or physical controls)	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M

Receptor Factor

Identified	Impacted drinking water well with detected contaminants or existing downgradient water supply well within 4 miles and groundwater is current source of drinking water (EPA Class I or IIA groundwater)	
Potential	Existing downgradient drinking water well beyond 4 miles with no contaminant detection(s) or no known drinking water wells downgradient and groundwater is currently or potentially usable for drinking water (i.e., EPA Class I or II groundwater) or other beneficial use (e.g., agricultural)	M
Limited	No known water supply wells downgradient and groundwater is not considered potential drinking water source and is of limited beneficial use (Class III)	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M
	Groundwater Category	**HIGH**

Soil Worksheet

Installation: Buckley Air Force Base

Site ID: NA **AFFF Release Area #:** AFFF 4

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
PFBS	0.002	126	0.0
PFOA	0.0034	0.126	0.0
PFOS	0.59	0.126	4.7
CHF Scale	**CHF Value**	**Contamination Hazard Factor (CHF)**	**4.7**
CHF > 100	**H (High)**	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	**M (Medium)**		
2 > CHF	**L (Low)**		
CHF Value		**CHF VALUE**	**M**

Migratory Pathway Factor		
Evident	Analytical data or observable evidence that contamination is present at a point of exposure	H
Potential	Contamination has moved beyond the source, could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined	
Confined	Low possibility for contamination to be present at or migrate to a point of exposure	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H
Receptor Factor		
Identified	Receptors identified that have access to contaminated soil	
Potential	Potential for receptors to have access to contaminated soil	
Limited	No potential for receptors to have access to contaminated soil	L
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	L
	Soil Category	**MEDIUM**

Site Background Information			
Installation:	Buckley Air Force Base	**Date:**	6/19/2020
Location (State):	Colorado	**Media Evaluated:**	Groundwater, Soil
Site Name and ID:	F-5 Crash Site - NA	**Phase of Execution (e.g., RI, Record of Decision (ROD)):**	Remedial Investigation (RI)
RPM's Name:	Scott Wilson	**Agreement Status (e.g., Federal Facility Agreement date signed):**	USEPA Administrative Order RCRA 3008(H)
OVERALL SITE CATEGORY: MEDIUM			

Site Summary	
Brief Site Description:	AFFF 5 is a F-5 crash sight from the 1980s. As part of the emergency response, approximately 100 to 200 gallons of AFFF were sprayed on the Lima Apron, located south of Taxiway G and J. No additional information is available regarding crash response activities (Aerostar 2019). AFFF 5 is primarily covered in concrete and asphalt pavement with areas of vegetation are located to the north and south.
Brief Description of Pathways:	One unconsolidated, surficial aquifer and three bedrock aquifers (the Denver Formation, the Arapahoe, and the Laramie – Fox Hills Aquifer) are present near BAFB. The surficial and Denver Formation are the most likely aquifers to be impacted by AFFF since the Arapahoe and Laramie – Fox Aquifers are beneath a confining layer. Near BAFB the surficial aquifer is comprised of wind – blown sand and silt and is present from 30 to 60 feet below ground surface. The Denver formation is approximately 850 feet thick beneath BAFB and is primarily composed of shale and claystone (70%) with irregularly dispersed beds of coarser – grained sediment. Regional groundwater flow in the Denver Formation is generally radially outward from the center of the basin and to the northwest to the South Platte River near BAFB. Since two of the three newly installed wells were slow to recharge, groundwater flow at AFFF 5 during the SI could not be determined. The assumed groundwater flow direction, based on historical information is to the southwest.
Brief Description of Receptors:	BAFB receives its drinking water from the City of Aurora. The City of Aurora obtains its drinking water from a series of surface water within the Rocky Mountains that are located up to 180 miles from BAFB. While a small percentage is generated from deep aquifer wells, screened below the Denver Formation, the location of these wells is more than 4 miles from BAFB. Multiple private domestic – use wells, that are less than 150 feet in depth are located within 4 miles of BAFB. The closest, drinking water well (total depth 100 feet) is approximately 1.1 miles east/northeast (upgradient) of AFFF 5. The closest downgradient well with a known depth is 2.2 miles southwest of AFFF 5. A domestic well of unknown depth is located less than one mile west of AFFF 5, which would be cross to downgradient of AFFF 5. AFFF 5 is primarily covered concrete and asphalt pavement (Lima Apron). The surface soil samples were collected north and south of the pavement in vegetated areas. While access to the surface soil is expected to be limited based on their proximity to active operations, Building 11661 is located southwest of AFFF 5 and Buildings 14501 and 911 are located northwest of AFFF 5.

Groundwater Worksheet

Installation: Buckley Air Force Base

Site ID: NA **AFFF Release Area #:** AFFF 5

Contaminant	Maximum Concentration (ug/L)	Comparison Value (ug/L)	Ratios
PFBS	0.097	40	0.0
PFOA	0.029	0.04	0.7
PFOS	0.044	0.04	1.1

CHF Scale	CHF Value	Contamination Hazard Factor (CHF)	1.8
CHF > 100	H (High)	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	M (Medium)		
2 > CHF	L (Low)		
CHF Value		CHF VALUE	L

Migratory Pathway Factor		
Evident	Analytical data or direct observation indicates that contamination in the groundwater has moved to a point of exposure (e.g., well)	
Potential	Contamination in the groundwater has moved beyond the source or insufficient information available to make a determination of Evident or Confined	M
Confined	Analytical data or direct observation indicates that the potential for contaminant migration from the source via groundwater is limited (possibly due to geological structures or physical controls)	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	M

Receptor Factor		
Identified	Impacted drinking water well with detected contaminants or existing downgradient water supply well within 4 miles and groundwater is current source of drinking water (EPA Class I or IIA groundwater)	H
Potential	Existing downgradient drinking water well beyond 4 miles with no contaminant detection(s) or no known drinking water wells downgradient and groundwater is currently or potentially usable for drinking water (i.e., EPA Class I or II groundwater) or other beneficial use (e.g., agricultural)	
Limited	No known water supply wells downgradient and groundwater is not considered potential drinking water source and is of limited beneficial use (Class III)	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H
	Groundwater Category	**MEDIUM**

Soil Worksheet

Installation: Buckley Air Force Base

Site ID: NA **AFFF Release Area #:** AFFF 5

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
PFBS	0.00033	126	0.0
PFOA	0.00049	0.126	0.0
PFOS	0.2	0.126	1.6
CHF Scale	**CHF Value**	**Contamination Hazard Factor (CHF)**	**1.6**
CHF > 100	**H (High)**	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	**M (Medium)**		
2 > CHF	**L (Low)**		
CHF Value		**CHF VALUE**	**L**

Migratory Pathway Factor		
Evident	Analytical data or observable evidence that contamination is present at a point of exposure	H
Potential	Contamination has moved beyond the source, could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined	
Confined	Low possibility for contamination to be present at or migrate to a point of exposure	
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H
Receptor Factor		
Identified	Receptors identified that have access to contaminated soil	
Potential	Potential for receptors to have access to contaminated soil	
Limited	No potential for receptors to have access to contaminated soil	L
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	L
	Soil Category	**LOW**

Site Background Information			
Installation:	Buckley Air Force Base	**Date:**	6/23/2020
Location (State):	Colorado	**Media Evaluated:**	Groundwater, Soil
Site Name and ID:	F-16 Crash Site - NA	**Phase of Execution (e.g., RI, Record of Decision (ROD)):**	Remedial Investigation (RI)
RPM's Name:	Scott Wilson	**Agreement Status (e.g., Federal Facility Agreement date signed):**	USEPA Administrative Order RCRA 3008(H)
OVERALL SITE CATEGORY: LOW			

Site Summary	
Brief Site Description:	AFFF 6 is a F‑16 crash site from 1995 that occurred west of the southern end of Runway 14/32. Specifically AFFF 6 is located between East Utah Circle and Runway 14/32. Approximately 200 gallons of AFFF were used as part of the emergency response and dispensed on the bare ground. No further response documentation is available (Aerostar 2019).
Brief Description of Pathways:	One unconsolidated, surficial aquifer and three bedrock aquifers (the Denver Formation, the Arapahoe, and the Laramie‑Fox Hills Aquifer) are present near BAFB. The surficial and Denver Formation are the most likely aquifers to be impacted by AFFF since the Arapahoe and Laramie‑Fox Aquifers are beneath a confining layer. Near BAFB the surficial aquifer is comprised of wind‑blown sand and silt and is present from 30 to 60 feet below ground surface. The Denver formation is approximately 850 feet thick beneath BAFB and is primarily composed of shale and claystone (70%) with irregularly dispersed beds of coarser‑grained sediment. Regional groundwater flow in the Denver Formation is generally radially outward from the center of the basin and to the northwest to the South Platte River near BAFB. The surficial aquifer was not encountered in two of the three well locations, so only one well was installed. Since groundwater flow at AFFF 6 during the SI could not be determined, the groundwater flow direction was based on historical information. The assumed groundwater flow direction is to the west/southwest (Aerostar 2019).
Brief Description of Receptors:	BAFB receives its drinking water from the City of Aurora. The City of Aurora obtains its drinking water from a series of surface water within the Rocky Mountains that are located up to 180 miles from BAFB. While a small percentage is generated from deep aquifer wells, screened below the Denver Formation, the location of these wells is more than 4 miles from BAFB. Multiple private domestic‑use wells, that are less than 150 feet in depth are located within 4 miles of BAFB. The closest, downgradient drinking water wells (total depths 82, 90, and 90 feet) are approximately 1 miles south/ southwest of AFFF 6. A domestic well of unknown depth is located approximately 0.5 miles cross to downgradient (south‑southeast) of AFFF 6. The water well of unknown depth is within the boundaries of BAFB. AFFF 6 is primarily covered with vegetation with small extents of surface soil present. Access to the surface soil is expected to be limited based on the proximity to active operations.

Groundwater Worksheet

Installation: Buckley Air Force Base

Site ID: NA **AFFF Release Area #:** AFFF 6

Contaminant	Maximum Concentration (ug/L)	Comparison Value (ug/L)	Ratios
PFBS	0.015	40	0.0
PFOA	0.0094	0.04	0.2
PFOS	0.016	0.04	0.4

CHF Scale	CHF Value	Contamination Hazard Factor (CHF)	0.6
CHF > 100	H (High)	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	M (Medium)		
2 > CHF	L (Low)		
CHF Value		CHF VALUE	L

Migratory Pathway Factor		
Evident	Analytical data or direct observation indicates that contamination in the groundwater has moved to a point of exposure (e.g., well)	
Potential	Contamination in the groundwater has moved beyond the source or insufficient information available to make a determination of Evident or Confined	
Confined	Analytical data or direct observation indicates that the potential for contaminant migration from the source via groundwater is limited (possibly due to geological structures or physical controls)	L
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	L

Receptor Factor		
Identified	Impacted drinking water well with detected contaminants or existing downgradient water supply well within 4 miles and groundwater is current source of drinking water (EPA Class I or IIA groundwater)	H
Potential	Existing downgradient drinking water well beyond 4 miles with no contaminant detection(s) or no known drinking water wells downgradient and groundwater is currently or potentially usable for drinking water (i.e., EPA Class I or II groundwater) or other beneficial use (e.g., agricultural)	
Limited	No known water supply wells downgradient and groundwater is not considered potential drinking water source and is of limited beneficial use (Class III)	
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	H
	Groundwater Category	**LOW**

Soil Worksheet

Installation: Buckley Air Force Base

Site ID: NA **AFFF Release Area #:** AFFF 6

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
PFOS	1E-10	0.126	0.0
CHF Scale	**CHF Value**	**Contamination Hazard Factor (CHF)**	**0.0**
CHF > 100	**H (High)**	$CHF = \sum \frac{\text{[Maximum Concentration of Contaminant]}}{\text{[Comparison Value for Contaminant]}}$	
100 > CHF > 2	**M (Medium)**		
2 > CHF	**L (Low)**		
CHF Value		**CHF VALUE**	**L**

Migratory Pathway Factor		
Evident	Analytical data or observable evidence that contamination is present at a point of exposure	
Potential	Contamination has moved beyond the source, could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined	
Confined	Low possibility for contamination to be present at or migrate to a point of exposure	L
Migratory Pathway Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	L
Receptor Factor		
Identified	Receptors identified that have access to contaminated soil	
Potential	Potential for receptors to have access to contaminated soil	
Limited	No potential for receptors to have access to contaminated soil	L
Receptor Factor	DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).	L
	Soil Category	**LOW**